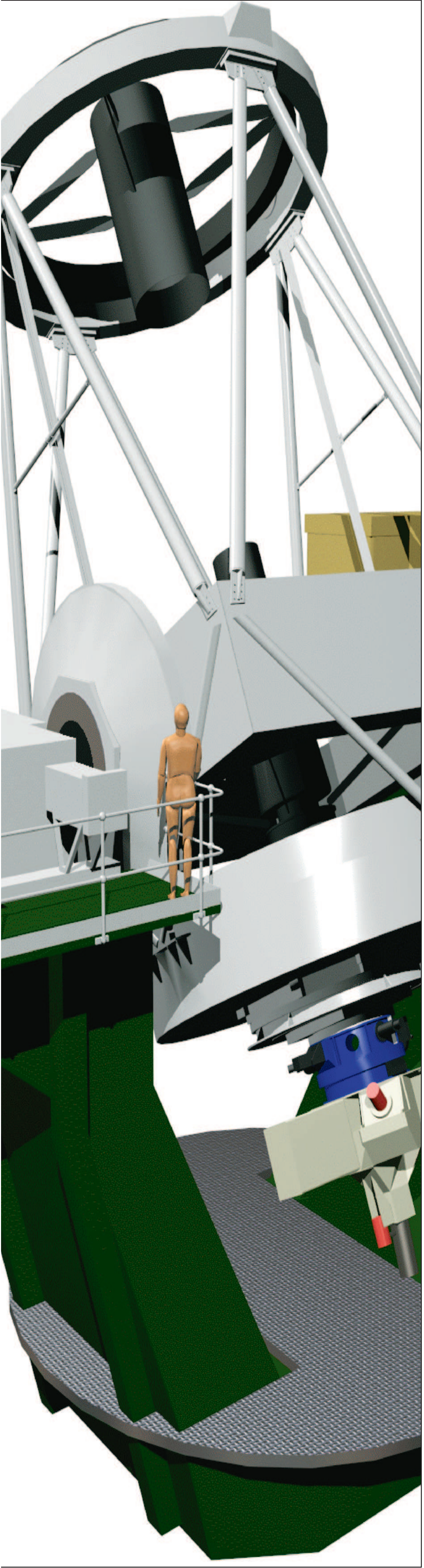


## Chapter 2

# New Instrumentation and Enhancements

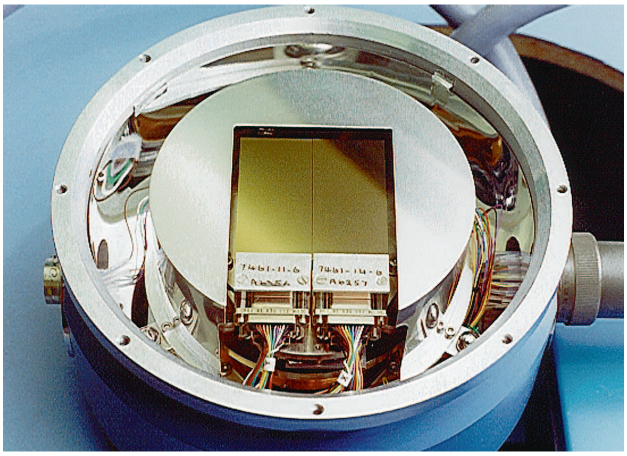
The ING telescopes continue to enjoy a high level of interest from instrument builders. Various developments are under way or have already been made to the telescopes during 1999, some of which are reported below.

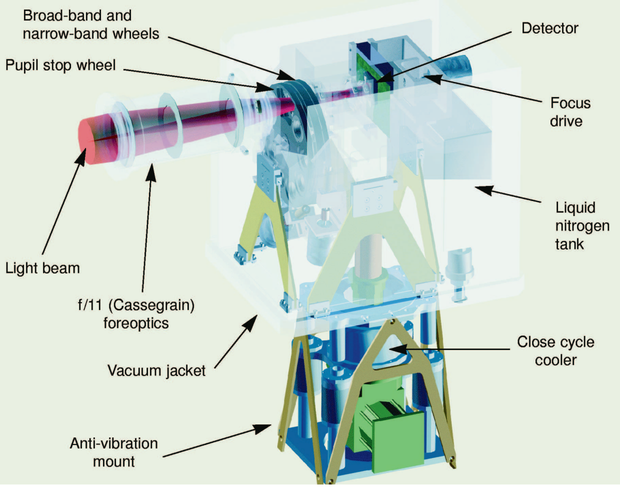
The twin CCD mosaic camera composed of two 2k×4k pixel EEV devices was commissioned in the WHT Prime Focus, replacing the single chip camera as the main imager. This was the first system on the WHT that was converted to the new data acquisition system based on an SDSU-2 controller. The new camera not only doubles the field-of-view compared to the previous single-chip camera, but in conjunction with speed gains from the new data acquisition system, imaging projects have become much more efficient. The substantial field of view of 16 by 16 arcmin together with the excellent response of the thinned EEV CCDs at short wavelengths makes it a highly competitive tool for deep imaging projects at short wavelengths.

ING have formally joined a CCD development project led by the University of Hawaii for the procurement of high-QE, large format CCDs. These thick, deep-depletion CCDs are being developed by MIT Lincoln Laboratory. Although the currently operational CCDs have excellent quantum efficiency in the blue, they do suffer badly from fringing at long wavelengths. The detectors obtained through the consortium involvement are expected to show little fringing as well as very good quantum efficiency.

Development of the new infra-red camera for the WHT, INGRID, made important progress during 1999, although commissioning will be later than was originally anticipated.

*From top to bottom, left to right: BVR image of M33 Galaxy, exposure time was 10s; The star-formation region M42, also known as the Orion nebula. Shown here is a 10s exposure true-colour image; Twin EEV CCD detector of the WHT Prime Focus camera. The new WHT prime focus camera contains two EEV 42-80 thinned CCDs butted along their long axes to provide a 4K x 4K pixel mosaic. Each pixel is 13.5μm square. A single detector comprises 2148 x 4128 pixels. The active area of the mosaic measures 55.8 x 55.35mm, with a 0.53mm gap between the chips.*



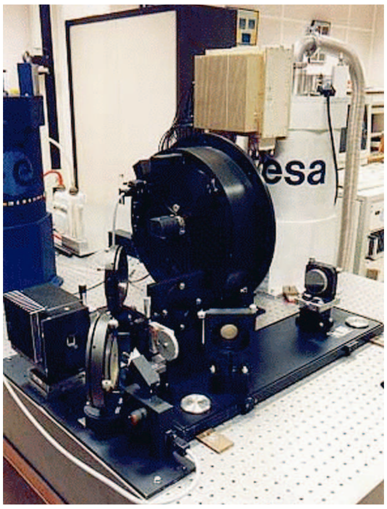

Broad-band and narrow-band wheels
Pupil stop wheel
Detector
Focus drive
Liquid nitrogen tank
Light beam
f/11 (Cassegrain) foreoptics
Vacuum jacket
Close cycle cooler
Anti-vibration mount

*A 3-D transparent model of INGRID showing in red the light beam from the telescope focusing on the infrared detector.*

This camera, which at its heart has a 1024×1024 pixel IR HgCdTe detector from Rockwell, will be used as a stand-alone IR imager in the Cassegrain focus, as well as the prime detector for the future adaptive optics system. For normal imaging the field-of-view will be over four minutes of arc. Delay in commissioning was mainly due to major rework that was required in various parts of the original design, in particular on the optics mounting arrangement to meet the very tight tolerances.

The WHT hosted the first on-sky trials of ESA's Super-conducting Tunnel Junction Camera, S-Cam, built by a team from ESTEC at Noordwijk, The Netherlands. The radically new technology deployed in this camera (breaking of Cooper pairs by incoming photons) permits measurement of both the energy and time of arrival of each photon striking the detector array. As the current incarnation of this technology an array of 6 by 6 pixel had been produced. The energy resolution at the moment reaches only about five, but future developments hold the promise of achieving a resolution of up to R~500. First science results of the pulsar in the center of the Crab nebula have been published.

Another new instrument that came to the WHT was SAURON, an integral-field grism spectrograph built at Centre de Recherche Astronomique de Lyon, in collaboration with the Universities of Leiden and Durham. SAURON splits the telescope's Cassegrain focal plane into approximately 1500 elements, using a lenslet array. For each element of the focal plane a spectrum is produced, providing a huge multiplex advantage over classical spectrographs. This design principle has been successfully pioneered at the CFHT in instruments such as TIGER and OASIS. SAURON targets a number of specific scientific aims and is ideally suited to explore the dynamical parameter space occupied by elliptical galaxies and the bars and bulges of spirals galaxies.

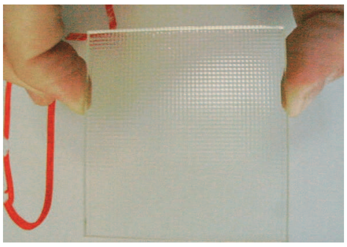


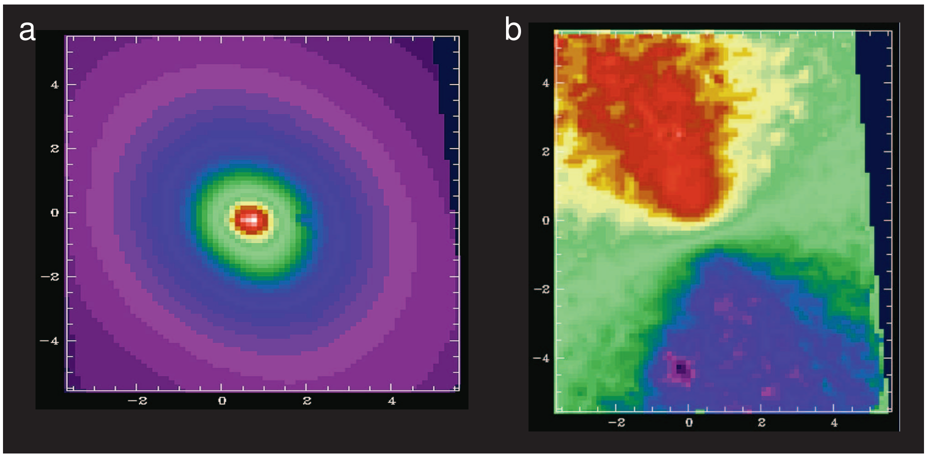
*ESA's S-Cam set up at ESTEC.*

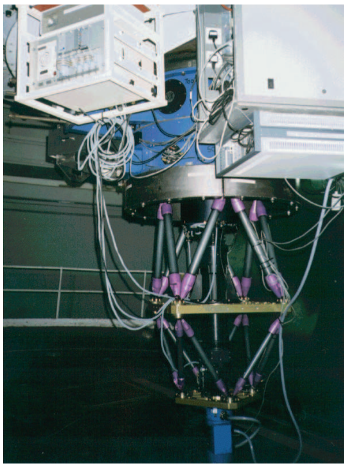
Another integral field instrument that came to the WHT was TEIFU, the thousand-element integral-field fibre feed for the existing WYFFOS fibre spectrograph. This instrument, built in Durham uses a lenslet array to feed the fibres and thus achieves a very high filling factor. TEIFU can be used either as a stand-alone fibre feed, or in conjunction with the future adaptive optics system for the WHT to facilitate spectroscopic observations at very high spatial resolution.

An ING Workshop was held in Sheffield to discuss the future direction of the observatory instrumentation plans with the community of ING users. Many useful contributions inspired much discussion between the over 70 registered participants. In particular the role that 4-m class telescopes will play in the era of the much larger telescopes was a topic of discussion. There appeared to be a reasonable consensus that the strategy for the WHT would be to concentrate its development

*From top to bottom, left to right: The SAURON lenslet array is made of fused silica, and consists of over 1600 square lenslets, each 1.35 mm on the side; SAURON measurements of M32. a) Reconstructed total intensity. b) Stellar mean velocity. The field of view is 9"×11", and the spatial sampling is 0.26"×0.26"; SAURON mounted on the Cassegrain port of the WHT.*







on wide field multi-object spectroscopy and on exploiting high spatial resolution through adaptive optics.

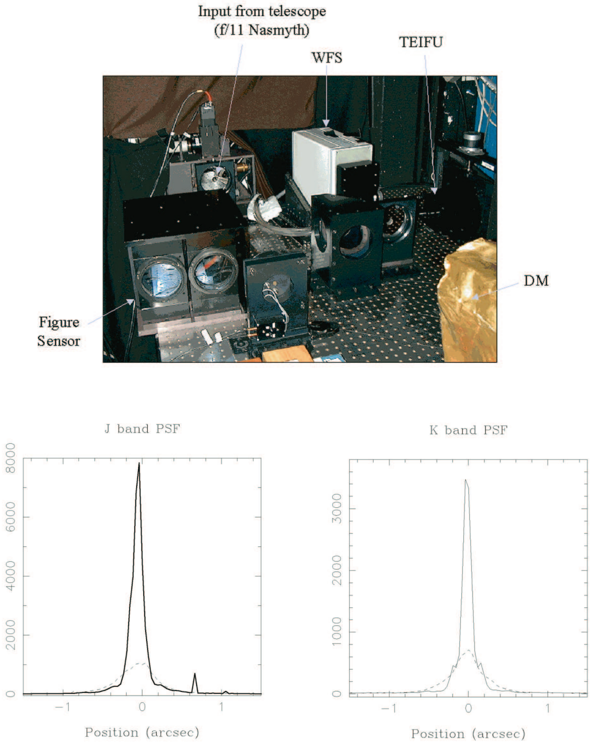
Following from this meeting an announcement of opportunity for new instrument ideas was sent out to the community. The ideas received all focussed on achieving high spatial resolution through adaptive optics. These proposals form the basis of future new instrument developments.

## ADAPTIVE OPTICS AT THE WILLIAM HERSCHEL TELESCOPE

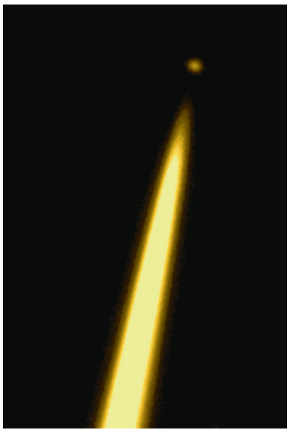
The Adaptive Optics (AO) programme for the WHT is a cornerstone development area at ING. Telescopes in the 4-m diameter range provide the ideal tools to exploit and develop AO techniques because, at this beam size, diffraction limited imaging at relatively short wavelengths and over moderately wide fields should be achievable. In this area 4-m class telescopes are likely to remain competitive next to the new generation of 8-m class telescopes.

During the summer important trial observations were carried out using ELECTRA whose adaptive-optics mirror will ultimately be at the heart of the WHT adaptive optics instrument, NAOMI. The tests were very encouraging and produced near diffraction-limited images in the J and K bands. Much experience was gained in optimising system performance, stability and calibration procedures.

The initial AO instrumentation will rely on natural guide stars to measure wavefront distortions. Optimal exploitation of AO would require the deployment of artificial guide stars produced by a laser beam since this would provide nearly full sky coverage. A sodium laser produces a fluorescent spot high in the Earth's atmosphere at an altitude of about 90 km, which is then used as an artificial star. A study was initiated to investigate whether the atmospheric conditions above La Palma are suitable for this technique and to look at the complexities of laser guide star deployment. This programme, led by Imperial College in London, resulted in first laser firing from a special purpose launch telescope in September. The very successful trials gave invaluable information and experience on both technical and atmospheric parameters. The brightness of the artificial star was measured, as well as the temporal variation and structure as function of height in the atmosphere. The full study will span about one year during which four laser runs will take place.



*Top: Schematic layout of ELECTRA at GHRIL (WHT). Bottom: ELECTRA J-band and K-band images of a star before and after correction.*



*A pseudocolour image of the laser scattering taken with a small telescope 3 m away from the laser launch. The small spot at the top is the sodium laser beacon.*

# INFRASTRUCTURE ENHANCEMENTS

The most important infrastructure enhancement at ING during the reporting year has been the upgrade programme of the computing facilities and network. The network backbone requirements were audited and enhanced to allow for the much higher data rates that are now produced by the telescopes. New cables and fibres were laid, new computers installed, and RAID disk storage systems will be installed early in 2000. Following this, ING will also acquire a Digital Video Disk (DVD) tower with ancillary computer equipment and software to facilitate archiving of the large data volumes. These incremental upgrades to date have been carried out without loss of essential services to the observers. Although the project is not fully completed yet, its positive impact has been noticed by observers.

*To carry out the work on the INT dome top shutter the largest crane on La Palma was hired to lift the half-tonne units.*

Repairs and major maintenance was carried out on the INT dome top shutter over the summer. Motors and drive system were replaced. Advantage of this stand-down period was also taken to replace pulleys and cables. All work was completed successfully within four days, with minimum loss of observing time.

ING's John Whelan library facilities were much extended thanks to the large number of books and journals received from the now closed Royal Greenwich Observatory. In order to accommodate this valuable addition the existing library space in the Santa Cruz de la Palma Sea Level Office was extended.